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DESCRIPTION

CONTACT DEVICE

TECHNICAL FIELD

The present invention relates to a contact device suitable for a high-load relay, an electromagnetic relay, etc.

BACKGROUND ART

Japanese Non-examined Patent Publication No. 2000-340087 discloses a conventional contact device. The conventional contact device comprises a fixed contact; a movable contact coming into contact with and separating from the fixed contact; a movable plate carrying the movable contact; a drive mechanism which drives the movable plate to make the contacting engagement of the movable contact with the fixed contact; and a housing which houses the fixed contact, the movable plate, and the drive mechanism. The movable plate is a Z shape having a contact member carrying the movable contact on its one surface, a leg upstanding from the contact member, and a supporting member which is coupled at its one end to the leg and is fixed at the other end to the drive mechanism. When the drive mechanism is energized, the movable plate moves downward to bring the movable contact into contact with the fixed contact.

In this kind of contact device, when the movable plate overtravels after the movable contact came into contact with the fixed contact, the supporting member is deformed, which gives a contact pressure to the contacts. As shown in FIG. 12A, the contact pressure is a resultant force F of two forces F1 and F2; the force F1 is a force applied to the movable contact 100 by the movable plate 120 along a moving direction of the movable contact 100 for bringing the movable contact 100 into contact with the fixed contact 110 (downward direction in FIG. 12A), and the force F2 is a force applied to the movable contact 100 by deformation of the supporting member 120a through the leg 120b. The force F2 intends to open the

leg 120 outward. Therefore, in this conventional contact device shown in FIG. 12A, a component force F3 parallel to a contact surface defined between the movable contact 100 and the fixed contact 110 is generated from the resultant force F, so, as shown in FIG. 12B, the leg 120b may pivot about its upper end S, and the movable contact 100 may slip sideways with respect to the fixed contact 110. Such side slip may cause a decrease of the contact pressure between the movable contact 100 and the fixed contact 110, which may increase a contact bounce time, and may cause contact weld, a breaking defect caused by an increase in transfer of a contact material, and a malfunction.

DISCLOSURE OF THE INVENTION

In view of the above problem, the object of the present invention is to provide a contact device which can prevent a side slip of the movable contact when it is switched.

The contact device in accordance with the present invention comprises fixed terminals respectively provided with fixed contacts; a movable plate carrying movable contacts each making a contacting engagement with each one of the fixed contacts; a drive mechanism which drives the movable plate to make the contacting engagement of the movable contacts with the fixed contacts; a housing which accommodates therein the fixed contacts, the movable plate, and the drive mechanism. The movable plate is a Z-shape having a contact member carrying the movable contacts, a leg upstanding from the contact member, and a supporting member which is coupled at its one end to the leg and is fixed at the other end to the drive mechanism.

The movable contacts are given a first force by the drive mechanism along a direction for bringing the movable contacts into contact with the fixed contacts and given a second force by deformation of the supporting member resulted from an overtravel of the movable plate through the leg.

The feature of the present invention resides in that the fixed contacts and

the movable contacts are arranged such that a resultant force of the first and second forces acts in a direction normal to a contact surface defined between the fixed contacts and the movable contacts. Therefore, a component force of the resultant force parallel to the contact surface is not generated, so a side slip of the movable contact can be prevented when the contacts are closed.

Preferably, the contact member has a cut between the movable contacts. By this cut, the stiffness of the contact member is decreased, which makes it easy for the contact member to deform in a moving direction of the contact member. Therefore, even if contact pairs have a difference in distance between the movable contact and the fixed contact, the difference can be absorbed by the deformation of the contact member, and the variation of time in which each contact is exposed to an arc is reduced. Therefore, variations in the amount of wear of the contact material and the amount of transfer of it do not arise, so a malfunction where some movable contact does not come into contact with the fixed contact can be prevented.

More preferably, the leg has a protrusion running along a direction in which the leg upstands. Such protrusion enhances the strength of the leg, and can prevent the buckling of the leg.

It is also preferable that a protrusion which is in contact with both surfaces of the leg and the contact member is provided at a connecting part between the leg and the contact member. Such protrusion enhances the strength of the connecting part and can prevent a change of an angle formed by the leg and the contact member. By preventing the change of the angle, a state where the resultant force acts in the direction normal to the contact surface can be maintained.

It is also preferable that the contact member has two movable contacts, and the leg upstands from a line joining each center of the two movable contacts. In this case, even if the angle formed by the leg and the contact member varies, the variation of an angle of the movable contact can be minimized because a distance from the connecting part between the contact member and the leg to the

movable contact is shortened. By minimizing the variation of the angle of the movable contact, a state where the resultant force acts in the direction normal to the contact surface can be maintained.

It is preferable that the drive mechanism has a bobbin on which a coil is wound, and the housing has a base which each of the fixed terminals penetrates, and the base and the bobbin are integrally molded from the same material along with a stopper for restricting a movement of the movable plate in a direction in which the movable contact separates from the fixed contacts. In this case, the number of parts can be reduced, which enables a simplification of an assembly work and a cost reduction.

It is also preferable that the housing has a base which each of the fixed terminals penetrates, and the base is integrally molded from the same material with an arc-extinguishing box that surrounds the fixed contacts and the movable contacts to extinguish an arc generated between the fixed contacts and the movable contacts.

Alternatively, it is also preferable that the housing comprises a base which each of the fixed terminals penetrates, and an arc-extinguishing cover which is attached to the base so that it surrounds the fixed contacts and the movable contacts to extinguish an arc generated between the fixed contacts and the movable contacts and covers the drive mechanism.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1A is a transverse sectional view of a contact device in accordance with an embodiment of the present invention, and FIG. 1B is a longitudinal sectional view of the contact device.

FIG. 2 is a diagram for explaining a mounting angle of a movable contact and a fixed contact of the contact device of FIG. 1.

FIG. 3 is a diagram for determining the mounting angle of the movable contact and the fixed contact.

FIG. 4A is a plan view of a movable plate of the device, and FIG. 4B is a vertical section of the movable plate.

FIG. 5A is a plan view of a preferred movable plate of the device, and FIG. 5B is a vertical section of the movable plate.

FIG. 6A is a plan view of another preferred movable plate of the device, and FIG. 6B is a vertical section of the movable plate.

FIG. 7A is a plan view of another preferred movable plate of the device, and FIG. 7B is a vertical section of the movable plate.

FIG. 8A is a plan view of another preferred movable plate of the device, and FIG. 8B is a vertical section of the movable plate.

FIG. 9A is a plan view of another preferred movable plate of the device, and FIG. 9B is a vertical section of the movable plate.

FIG. 10A and FIG. 10B are diagrams for explaining a base and an arc-extinguishing box of the device.

FIG. 11A and FIG. 11B are diagrams for explaining a base and a bobbin in accordance with another embodiment of the present invention.

FIG. 12A, FIG. 12B and FIG. 13 are diagrams for explaining a conventional contact device.

BEST MODE FOR CARRYING OUT THE INVENTION

Hereinafter, the present invention will be described in more detail with reference to the accompanying drawings.

FIG. 1A and FIG. 1B show a contact device in accordance with a first embodiment of the present invention. A housing 1 of the contact device is composed of a base 2 made of a synthetic resin having an insulating property and a cover 3. A pair of fixed terminal holes 2a, 2a into which each fixed terminal 4 is inserted is formed through the base 2 at one end in the longitudinal direction of the base 2. The fixed terminal holes 2a, 2a are located side by side along a direction perpendicular to the longitudinal direction of the base 2. Each of the fixed terminals

4, 4 is a metal plate, one end of which protrudes from the housing 1 through the base 2, and the other end is in the housing 1 and has a fixed contact 5. A mounting angle of the fixed contacts 5, 5 will be described later in detail.

A bobbin 6 is integrally molded with the base 2 using the same synthetic resin at the other end in the longitudinal direction of the base 2. The bobbin 6 has a cylinder-shaped cylindrical section 6a and flanges 6b and 6c at both ends of the cylindrical section 6a. A coil 7 is wound on the outer surface of the cylindrical section 6a. Both ends of the coil 7 are electrically connected with two coil terminals 8, 8, which penetrate the base 2 near the bobbin 6 side by side in a direction perpendicular to the longitudinal direction of the base 2. A slot 2b that has an opening on the right side in Fig. 1 is provided between the base 2 and the flange 6c on the base side, into which a cross-member 9a of a L-shaped yoke 9 is slid and inserted. The cross-member 9a has a circular hole 9c which will communicate with the inside of the cylindrical section 6a of the bobbin 6 when the yoke 9 is inserted into the slot 2b, and one end of a core 10 is pressed thereinto through the inside of the cylindrical section 6a. The other end of the core 10 is provided with a pole piece 10a that is larger than the cylindrical section 6a in diameter. The pole piece 10a is on the flange 6b.

An L-shaped return spring 11, which is formed by bending a thin plate, is fixed at its one end to a vertical member 9b of the yoke 9, and the other end 11b of it is fixed to an armature 12. The armature 12, which is formed into a plate shape from a magnetic material, is fixed at its center section to the return spring 11, and is disposed so that one end 12a of it is on the upper surface of the vertical member 9b of the yoke 9 and the other end 12b of it opposes to the pole piece 10a. The armature 12 is supported by the return spring 11 so that it can pivot about one end 12a, and is energized by the return spring 11 in a direction separating from the pole piece 10a. That is, while the coil 7 is not energized, the armature 12 is located in an off-position where the armature is separate from the pole piece 10a by spring force of the return spring, and when the coil is energized, the armature 12 pivots

against the spring force by magnetic force acting between the armature 12 and the pole piece 10a, and the other end 12b comes into contact with the pole piece 10a. The bobbin 6, the coil 7, the core 10, the yoke 9, the return spring 11, and the armature 12 constitute a drive mechanism.

A movable plate 14 is fixed to the upper surface of the armature 12 through a fixing member 13. The fixing member 13 is made of a synthetic resin, into which one end of the movable plate 14 (a supporting member 14c) and the other end 11b of the return spring 11 are insert-molded. The movable plate 14 is formed from a metallic thin plate having a spring force, and is formed into a Z-shape having a contact member 14a carrying movable contacts 15, 15, a leg 14b upstanding from the contact member 14a, and the supporting member 14c which is coupled at its one end to the leg 14b and is insert-molded into the fixing member 13 at the other end, as mentioned above. The movable contacts 15, 15 are disposed on the contact member 14a side by side in a direction perpendicular to the longitudinal direction of the base 2 in spaced relation to each other so as to make a contacting engagement with each fixed contact 5. A mounting angle of the movable contacts will be described in detail later.

An arc-extinguishing box 16 for extinguishing an arc generated between the movable contacts and the fixed contacts is provided around the movable contacts 15, 15 and the fixed contacts 5, 5. The arc-extinguishing box 16, which is made of a synthetic resin which has an insulating property and excels in an arc extinguishing property, is in the form of a box having openings on the base side and on the drive mechanism side.

The contact device of this embodiment, constituted as above, will work as below.

When the coil terminals 8 are energized to excite the coil 7, the armature 12 is attracted to the pole piece 10a against the spring force of the return spring 11 by the magnetic force. And, the movable plate 14 fixed to the armature 12 pivots to bring the movable contacts 15, 15 into contact with the fixed contacts 5, 5. When

the armature 12 overtravels toward the pole piece 10a after that, the supporting member 14c of the movable plate is deformed and gives the contact pressure. When the energization of the coil terminals is stopped, the magnetic force goes off, and the armature 12 is separated from the pole piece 10a by the spring force of the return spring 11 to break the contacting engagement of the movable contacts 15, 15 with the fixed contacts 5, 5. The pivot motion of the armature 12 is regulated when the supporting member 14c of the movable plate 14 comes in contact with a stopper 17 provided above the flange 6b of the bobbin 6.

Hereinafter, the mounting angle of the fixed contacts and the movable contacts will be explained in detail.

The contact pressure F between the movable contacts and the fixed contacts is a resultant force of two forces F1 and F2; the force F1 is a force applied to the movable contacts by the movable plate 14 driven by the drive mechanism along the moving direction of the movable plate 14 for bringing the movable contacts into contact with the fixed contacts; the force F2 is a force applied to the movable contacts 14b through the leg 14b by deformation of the supporting member 14c resulted from a movement of the movable plate 14 after the movable contacts came into contact with the fixed contacts (that is, an overtravel of the movable plate 14). In other words, the force F2 is a force that intends to open the leg 14b outward by deformation of the supporting member 14c. As shown in FIG. 2, in this contact device, the mounting angle of the fixed contacts and the movable contacts are decided so that the contact pressure F acts in a direction normal to a contact surface defined between the fixed contacts and the movable contacts. Therefore, a component force parallel to the contact surface of the fixed contacts and the movable contacts becomes zero, so the movable contacts does not slip sideways with respect to the fixed contacts.

Concretely speaking, the mounting angle θ will be determined as follows: first a vertical component force Fy and a horizontal component force Fx of the contact pressure F are measured (or calculated by simulation), as shown in FIG. 3.

And then, the vertical component force Fy and the horizontal component force Fx are substituted into the following equation to determine the mounting angle θ:

$$\theta = \arctan\ (Fx / Fy)$$

In the contact device constituted as mentioned above, because the movable contacts will not slip sideways, a contact bounce time is shortened, and contact weld, a breaking defect, and a malfunction can be prevented. Therefore, the reliability of the contact device is improved.

FIG. 4A is a plan view of the movable plate 14, and FIG. 4B is a vertical section of it. The supporting member 14c is generally a pentagon, and it has circular holes 14d, 14d at both corners of the back section so as not to drop off from the fixing member 13 after it was insert-molded into the fixing member. The leg 14b is a narrow rectangle, and it extends downward from the edge of the supporting member 14c to connect between the supporting member 14c and the contact member 14a. The contact member 14a is also a narrow rectangle and has standing pieces 14e, 14e at both ends in the longitudinal direction of it for improving a current breaking property. The standing pieces 14e, 14e are formed by bending the both ends of the contact member 14.

Preferably, as shown in FIGS. 5A and 5B, the contact member 14a has a cut 14f between the movable contacts 15, 15. In general, when a contact device turns on or turns off a direct current of high voltage, it is necessary to raise an arc voltage to (or higher than) a voltage between contacts so as to extinguish the arc in the shortest possible time. Therefore, in this embodiment, two contact pairs are prepared to raise the arc voltage. However, if the distance between the fixed contact and the movable contact differs between the two contact pairs because of variations in parts dimension, mounting accuracy, and so on, a condition where only one contact pair makes the contacting engagement and the other contact pair does not make the contacting engagement may arise, as shown in FIG. 13. In such a case, a time in which each contact is exposed to the arc may differ between

the contact pairs, and, as a result, the amount of wear of the contact material and the amount of transfer of it may vary from contact to contact. This may lead to a malfunction. By providing the cut 14f, the stiffness of the contact member 14a is decreased, which makes it easy for the contact member 14a to deform in a moving direction of the contact plate. Therefore, even if there is a difference in distance between the two contact pairs, the contact member can absorb the difference by deforming. In addition, in this embodiment, the cut 14f is located on a center line in the longitudinal direction of the contact member 14a, and it extends from one edge of the contact member to the center of it.

As a substitute for the cut 14f, as shown in FIGS. 6A, 6B, two contact members 14a, 14a may be provided to absorb the difference in distance of the contacts. Each contact member is connected to the supporting member 14c through the leg 14b.

Preferably, as shown in FIGS. 7A, 7B, the leg 14b has a long and narrow protrusion 14g running along a direction in which the leg 14b upstands (in other words, a longitudinal direction of the leg). The protrusion 14b enhances the strength of the leg, so it can prevent the buckling of the leg 14b even if an excessive stress is applied thereto.

It is also preferable that a protrusion 14h which is in contact with both surfaces of the leg 14b and the contact member 14a is provided at a connecting part between the leg and the contact member, as shown in FIGS. 8A, 8B. The protrusion 14h can prevent a change of the angle of the movable member 14a with respect to the leg 14b. If the angle of the movable member 14a with respect to the leg 14b changes when the movable plate 14 overtravels, the direction in which the contact pressure F acts will deviate from a direction normal to the contact surface defined between the fixed contacts and the movable contacts. By preventing the change of the angle by providing the protrusion 14h, it becomes possible to maintain the state where the contact pressure F acts in the direction normal to the contact surface, and the side slip of the movable contacts can be prevented

certainly.

Alternatively, as shown in FIGS. 9A, 9B, it is also preferable that the leg 14b upstands from a line joining each center of the two movable contacts. In this case, even if the angle of the contact member 14a with respect to the leg 14b varies when the movable plate 14 overtravels, the variation of the angle of the movable contacts can be minimized. Therefore, it becomes possible to suppress a deviation of the contact pressure F from the direction normal to the contact surface, and the side slip of the movable contacts can be prevented certainly.

As shown in FIGS. 10A, 10B, in this contact device, the base 2, the bobbin 6, and the stopper 17 are integrally molded from the same material (a synthetic resin having an insulating property). The stopper 17 comprises two L-shaped pieces located at both edges of the flange 6b along a direction perpendicular to the longitudinal direction of the base 2, and each piece further comprises a vertical member 17a upstanding in the axial direction of the bobbin 6 from the upper surface of the flange 6b and a cross-member 17b extending inward from the top of the vertical member 17a. The pivot motion of the movable plate 14 is regulated when the supporting member 14 comes in contact with an under surface of the cross-member 17b. By integrally molding the base 2, the bobbin 6, and the stopper 17, the number of parts can be reduced, which enables a simplification of an assembly work and a cost reduction.

The base 2 has a recessed area 2c with an upper part and a left side surface in FIG. 10B opened, and the arc-extinguishing box 16 is slid thereinto from the left side and attached to it. The positioning of the arc-extinguishing box 16 with respect to the base 2 can be done easily by fitting two protrusions 2d, 2d provided at the bottom of the recessed area 2c into two recesses 16a, 16a provided on the undersurface of the arc-extinguishing box 16.

The height of the arc-extinguishing box 16 and the length of the fixed terminal 4 are decided so that the fixed contacts are located in the middle of the arc-extinguishing box in height. Therefore, when the movable contacts come in

contact with the fixed contacts, the size of the space upper than the contacts in the arc-extinguishing box 16 becomes equal to that of the space lower than the contacts, so the space for stretching the arc generated when the contacts are opened or closed can be divided equally.

Although the base 2, the bobbin 6, and the stopper 17 are integrally molded in this embodiment, the base 2 and the arc-extinguishing box 16 may be integrally molded from the same material (a synthetic resin which has an insulating property and excels in an arc-extinguishing property). In this case, the base 2 has a recessed area 2e with an upper part and a right side surface in FIG. 11B opened, and a integrally-molded bobbin 6 with the stopper 17 is slid thereinto and fixed thereto by an adhesive. In this case too, the number of parts can be reduced, which enables a simplification of an assembly work and a cost reduction.

In another embodiment, as a substitute for the arc-extinguishing box 16 and the cover 3, an arc-extinguishing which is attached to the base so that it surrounds the fixed contacts and the movable contacts and covers the drive mechanism may be used. That is, the housing 1 is composed of the base 2 and the arc-extinguishing cover, and the arc-extinguishing cover is used both as the arc-extinguishing box 16 and the cover 3. The arc-extinguishing cover is formed from a synthetic resin which has the insulating property and excels in the arc-extinguishing property. In this embodiment too, the number of parts can be reduced, and an assembly work can be simplified, and the cost can be reduced.